

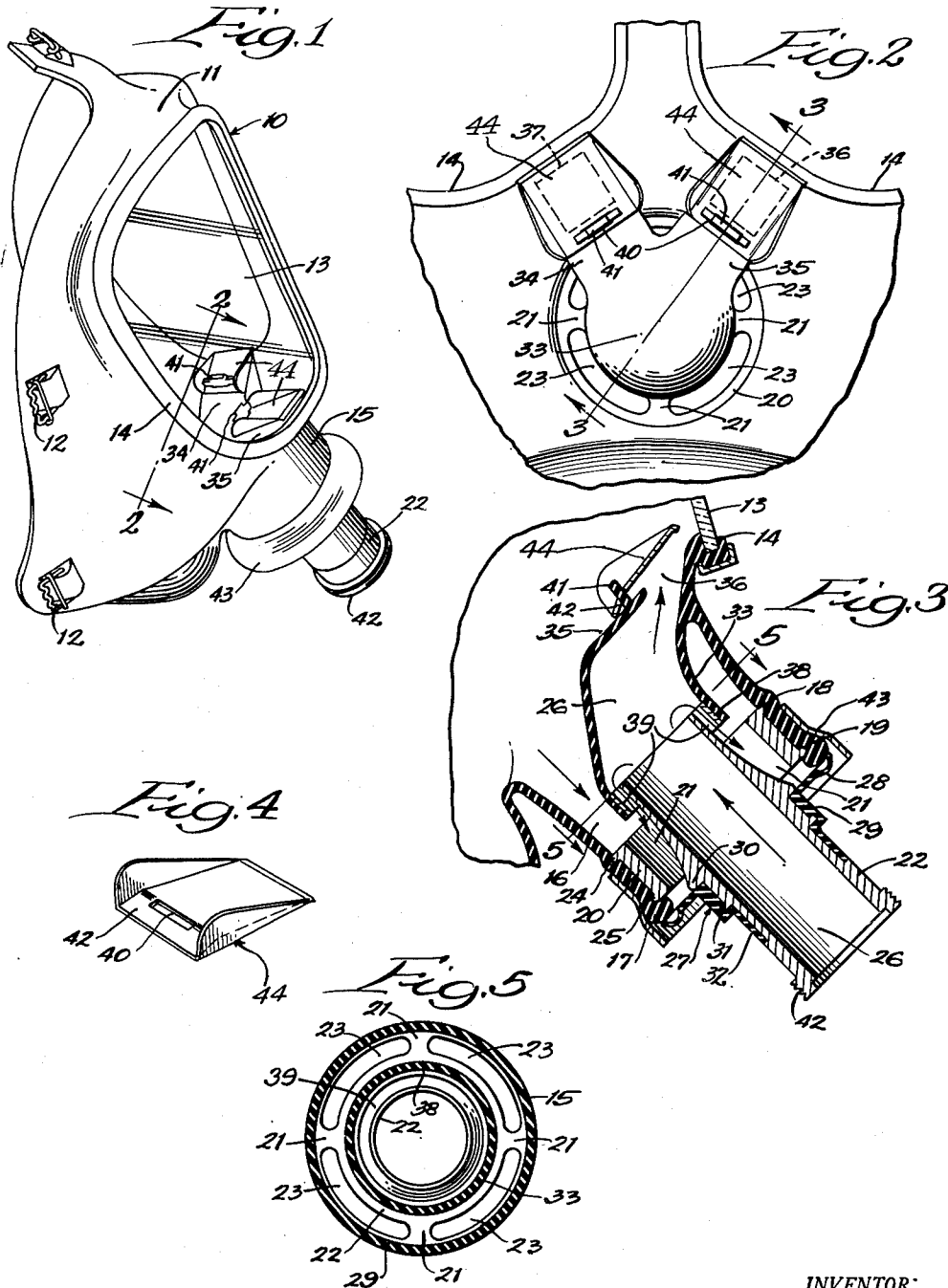
July 20, 1954

G. M. GLIDDEN

2,684,066

PRESSURE REGULATOR STRUCTURE FOR PRESSURE-TYPE GAS MASKS

Filed Nov. 13, 1951



INVENTOR:  
*Galen M. Glidden,*  
 BY  
*Dawson & Orms,*  
 ATTORNEYS.

## UNITED STATES PATENT OFFICE

2,684,066

PRESSURE REGULATOR STRUCTURE FOR  
PRESSURE-TYPE GAS MASKSGalen M. Glidden, Wheaton, Ill., assignor to Acme  
Protection Equipment Company, Chicago, Ill.,  
a partnership

Application November 13, 1951, Serial No. 256,014

6 Claims. (Cl. 128—141)

1

This invention relates to a pressure regulator structure for pressure-type gas masks.

The type of gas mask with which this invention is particularly concerned is commonly referred to as pressure-type or compressed air gas masks. In this type of mask, instead of the air being drawn into the face piece by the inhalation of the wearer from the surrounding atmosphere, compressed air is supplied to the interior of the mask through a hose connection. Generally, compressed air is supplied to these masks at a sufficient pressure to assure a continuous flow of air through the face piece. Because of this distinctive feature of the pressure-type masks, they present unique problems of design and operation, which are not presented with the ordinary gas masks.

One of the primary problems associated with pressure-type masks arises out of the desire to provide a large volume of air flow through the face piece with a very small pressure rise within the face piece. Substantial increases in pressure within the face piece above atmospheric are undesirable because they tend to distort the face piece and to force portions thereof engaging the face of the wearer away from the wearer's face, and thereby tend to break the seal between the mask and the head of the wearer. The peculiar difficulties presented by the conflicting criteria of large volume of air flow and small pressure rise is made more apparent by considering a typical standard established for the performance of pressure-type gas masks. One such standard is that of the United States Bureau of Mines which requires that under normal operating conditions that at least 6 cubic feet of air can be passed through the face piece per minute with a pressure rise within the face piece of less than 1" of water above atmospheric. Other governmental agencies and private organizations have similar standards.

In pressure-type gas masks of the type heretofore employed for a given volume of air per minute through the face piece, the exhalation valve will open a given amount which is just sufficient to allow the required volume of air to escape. In other words, since the structure of the valve member is such that it is yieldably biased towards the closed position, it must be forced open by the pressure of the air within the face piece, and the size of the opening will be determined by the volume of air being forced through the face piece. It can thus be seen that the air must exert pressure on the exhalation valve, and that the result of this pressure is nec-

2

essarily the creation of a back pressure within the face piece. Because of the work done by the air on the exhalation valve, it must be delivered at a slightly greater pressure than if the valve remained open without the application of force by the moving air. Thus, the pressure within the face piece, for a given volume of air, will rise to an equilibrium value which is somewhat above the minimum pressure that could be maintained in the mask if the development of back pressure by the gas because of the work done by it on the exhalation valve was reduced or eliminated. In the light of this analysis, it can now be better understood as to why it is extremely difficult to pass a large volume of air (6 cubic feet per minute) through the face piece of a mask equipped with a conventional type of exhalation valve without the equilibrium pressure within the mask rising to an objectionable value (above 1 inch of water). The problem is further complicated by the fact that there are inevitable fluctuations in the supply of compressed air, as well as unavoidable mechanical vibrations in the masks, which frequently causes individual masks to fail to meet the required standards. This may lead to the rejection of a shipment of masks by the buyer, which is a serious matter from the standpoint of the manufacturer.

It is therefore a general object of this invention to develop a pressure regulator structure for pressure-type gas masks to substantially overcome the above problem by reducing the equilibrium pressure within the face piece for a given volume of air to a value sufficiently low that there is a margin of safety between the pressures normally corresponding to the particular volume of air flow and the maximum permissible pressure. It is a further and more specific object of this invention to provide a means of opening the conventional exhalation valve in excess of its normal opening for a given volume of air to reduce the back pressure developed by the exhausted air acting on the valve. Further objects and advantages will appear as the specification proceeds.

As stated generally, this invention involves the formation of a by-pass providing a passage communicating with the interior of the intake conduit and terminating within the face piece in the vicinity of the exhaust opening valve means. The by-pass is adapted to direct a stream of air against the exhalation valve means traveling at a higher velocity than the air expelled there-through from the face piece. The result of this structure is that the exhalation valve means is caused to open in excess of the normal amount

3

for the volume of air being forced through the face piece. This enables the air to pass through the exhalation valve without doing as much work thereon, and therefore with the creation of a lesser amount of back pressure. Thus, the pressure within the face piece is reduced from the pressure normally associated with the particular volume of air.

For purpose of illustrating this invention more concretely it is now desired to refer to the accompanying drawings in which the pressure regulator structure just described is applied to a pressure-type gas mask employing concentric intake and exhaust conduits and a diaphragm-type exhalation valve. However, it will be apparent from the following that this invention is readily applicable to all pressure-type masks having an intake conduit and an adjacent exhaust opening equipped with a unidirectional valve means of variable volumetric capacity opening automatically in proportion to the volume of air forced through the face piece.

This invention is illustrated in a typical embodiment in the accompanying drawing, in which—

Figure 1 is a perspective view of a pressure-type gas mask equipped with the pressure regulator structure of this invention; Fig. 2, a fragmentary plan view of the interior of the mask taken on line 2—2 of Fig. 1; Fig. 3, a partial vertical sectional view of the mask taken on line 3—3 of Fig. 2; Fig. 4 a perspective view of one of the dead air check valves employed in the mask illustrated in the preceding figures, and Fig. 5, a sectional view of the face piece extension taken on line 5—5 of Fig. 3.

Turning now to the drawings, the gas mask is designated generally at 10 and it includes a face portion 11 for snugly fitting over the face of the wearer. The face portion may be provided with a plurality of buckles 12 for receiving straps for securing the face portion to the face of the wearer. The gas mask is also provided with a pair of lenses or windows 13 which are held in place in the face portion 11 by means of rims 14. The face portion 11 of the gas mask may be suitably molded from rubber or similar material.

In the illustration given, the face portion 11 of the gas mask is integrally formed with an exhaust conduit extension 15 providing interiorly an exhaust passage 16. The exterior end of extension 16 is adapted to provide an annular valve seat 17, and the lower portion of extension 15 is grooved internally at 18 and 19 so that the concentric member can be secured therein. In the illustration given, this member consists of a ring member 20 integrally connected by means of webs 21 to a tubular intake conduit 22, as seen more clearly in Fig. 3. Web connections 21 are spaced apart to provide a plurality of passages 23 therethrough, as seen best in Fig. 2. Ring 20 is provided with a pair of shoulders 24 and 25 which cooperate with grooves 18 and 19 in retaining ring 20 and thereby intake conduit 22 in centered relation with respect to exhaust conduit 15. Thus, it can be seen that the mounting of intake conduit 22 concentrically within exhaust conduit 15 causes exhaust passage 16 to assume an annular form, and that inlet passage 26 is provided within intake conduit 22.

A diaphragm exhalation valve 27 is mounted on intake conduit 22, as shown more clearly in Fig. 3. This is accomplished by forming exhalation valve 27 out of flexible, resilient material such as rubber with a disk portion 28 and a sleeve

4

portion 29. The sleeve portion is locked to conduit 22 by abutting against shoulder 30 and by having portions engaging ridge 31 and seating within recess 32. Disk portion 28 of diaphragm valve 27 is constructed so that its outer periphery normally rests against valve seat 17 to close annular exhaust passage 16, but opening an amount in proportion to the volume of air forced through the face piece, as indicated in Fig. 3.

In the illustration given, the inner end of conduit 22 is received within an integral intake conduit extension 33 dividing to form outlet extensions 34 and 35, as seen more clearly in Fig. 2. Thus, interiorly member 33 provides an extension of intake passage 26 leading upwardly through the interior of the forked extensions 34 and 35 to inlet openings 36 and 37 adjacent windows 13.

It has been discovered that the objects of this invention can be accomplished by providing a by-pass between intake passage 25 and exhaust passage 16. This by-pass can be constructed in any suitable manner for by-passing a portion of the incoming air within passage 26 into passage 16 in such a way as to form a stream of air directed against disk portion 28 of diaphragm valve 17. One convenient method of accomplishing this result is illustrated in Fig. 3. The lower end of intake extension 35 is provided interiorly with a ring 38 disposed about the inner end of intake conduit 22. By having the internal diameter of ring 38 of larger diameter than the external diameter of the top of conduit 22, there is provided therebetween an annular by-pass passageway 39 which is oriented to direct streams of air towards diaphragm valve portion 28. It will be understood that it is not necessary to have by-pass 39 extend entirely around the top of conduit 22, and that if desired ring 38 can be rigidly secured by means of webs or similar members to the top of conduit 22 to maintain the ring and conduit in concentric relation. However, it has been found that this is not necessary, and that ring 38 can be allowed to float with respect to conduit 22, since regardless of its position with respect to the top of conduit 22 the required streams of air will be directed downwardly toward a sufficient extent of valve portion 28.

It is preferable to adapt the portion of intake conduit 22 above the inlet to by-pass passageway 39 to provide a passage of reduced cross-sectional area for maintaining a higher pressure within the intake conduit in the region of the inlet to passage 39 than within face piece 11. In other words, it is desired to provide pressure-reducing means inwardly of the by-pass provided between ring 38 and the top of conduit 22 for maintaining a higher pressure in the region of the by-pass than within the face piece. The reason for this is that best results are achieved when the streams of air directed against valve portion 28 are traveling at considerably higher velocity than the air expelled through exhaust passage 16 from within face piece 11. This can be accomplished most easily by restricting the cross-sectional area of the upper portion of passage 26 so that there will be a pressure drop across the restriction in the passage. For example, in the illustration given the outlet openings 36 and 37 are of relatively small cross-sectional area. With the particular structure shown, it is also preferred to provide baffle check valves 44 for further restricting inlet openings 36 and 37, and to direct the air entering the face piece against windows 13. In other words, baffle check valves 44 serve at least three purposes. These mem-

5

bers serve to further reduce the cross-sectional area of openings 36 and 37 to increase the pressure drop from within passage 26 to the interior of face piece 11. They also serve to direct the incoming air against windows 13 to prevent fogging of the windows. A further purpose of members 44 is that they serve to keep the air from striking directly against the eyes of the wearer. Baffle check valves 44 can be mounted in any suitable manner such as by providing the valves with slots 40 through which T-shaped tongues 41 can be inserted to secure the valves to extensions 34 and 35. Preferably, the rear portion of valve members 44 is bent downwardly at 42, as shown more clearly in Figs. 3 and 4, so as to engage the upper surfaces of extensions 34 and 35 when the valve has opened a limited distance, as illustrated in Fig. 3.

If desired the lower end of conduit 22 can be provided with a threaded connection 42 for the attachment of a hose coupling. Also, if desired, extension 15 can be equipped with a cylindrical guard 43 to protect diaphragm valve 27.

#### Operation

Pressure-type gas masks equipped with the pressure regulator structure of this invention can be operated substantially the same way as conventional pressure-type masks. For example, in the mask shown in the drawings, it is only necessary for the hose supplying the compressed air to be connected to threaded portion 42 of intake conduit 22, and the mask positioned on the head of the wearer to produce a tight seal between the peripheral portions of the face piece and the head of the wearer. The relatively small cross-sectional area of openings 36 and 37 in cooperation with the dead air check valves 44 will effectively maintain the pressure within passage 26, and particularly in the region of by-pass 39, considerably higher than the pressure within the face piece 11. This will insure that a portion of the air will be by-passed through passage 39 to form streams of air of relatively high velocity directed against valve portion 28. Valve portion 28 will thus be displaced from valve seat 17 by a greater distance than it would normally be displaced with the particular volume of air flowing through the mask.

In actual operation, it has been found that the direction of streams or jets of air traveling at higher velocity than the air expelled through the exhaust opening from the face piece brings about a substantial reduction in equilibrium pressure within the face piece. Thus, it is possible to considerably increase the volume of air forced through the face piece per unit of time without increasing the pressure therein to more than the permissible limit. It will be understood that the volume of air moving through the face piece will be momentarily increased by the exhalation of the wearer. For example, the volume may be increased during the intervals of exhalation from 6 cubic feet per minute to 8 cubic feet per minute. Thus, under conditions of actual operation, a standard mask having either a single flutter valve or a single diaphragm valve may exhibit pressures within the face piece of from 24 to 26 mm. because of this variation in volume. In comparative tests on standard masks normally producing pressures around or slightly above the permissible limit of 25 mm. at a volume flow of 6 cubic feet per minute (United States Bureau of Mines) it was determined that by equipping the masks with the pressure regulator structure of this invention

6

that the equilibrium pressure within the mask between exhalation intervals could be maintained around 18 mm. at 6 cubic feet per minute, while the pressure during exhalation intervals could be held below 23 mm. It will therefore be apparent that this invention can be employed to effectively control the pressure within the face piece of compressed air gas masks.

The pressure regulator structure of this invention for purpose of illustration has been discussed mainly in connection with gas masks equipped with diaphragm-type exhalation valves, and particularly with a type of mask in which the intake and exhaust passages are concentric. However, I wish it clearly understood that this invention can be advantageously employed in a wide variety of compressed air gas masks. It has been found to give excellent results when incorporated in gas masks having separate intake and exhaust conduits with the exhaust conduit having a flutter-type valve therein. With this type of mask, it has heretofore been necessary to use 2 exhaust outlets equipped with flutter-type valves to maintain the pressure within the face piece below the permissible upper limit. By employing the pressure regulator structure of this invention, it is possible to eliminate the extra exhaust outlet and exhalation valve.

While in the foregoing specification for purpose of illustrating this invention it has been shown in a particular embodiment and the details of the illustrated embodiment have been extensively discussed, it will readily be apparent to those skilled in the art that this invention is capable of a wide variety of embodiments in pressure-type gas masks, and that the details of construction can be varied widely from those discussed herein.

#### I claim:

1. A pressure regulator structure for a pressure-type gas mask, comprising in combination concentrically arranged intake and exhaust conduits communicating with the interior of the face piece of said mask, the exhaust conduit being outermost to provide an annular exhaust passage between the outer exhaust conduit and the inner intake conduit, said exhaust passage being equipped with uni-directional exhaust valve means of variable volumetric capacity opening automatically in proportion to the volume of air forced through said face piece, said intake conduit having an outlet at the inner end thereof of reduced cross-sectional area cooperating with check valve means to produce a pressure drop across said opening and valve means from the interior of the intake conduit to the interior of the face piece, said check valve means also providing a baffle to direct the incoming air away from the eyes of the wearer, and a by-pass providing a passage extending from a lower point in said intake conduit into said annular exhaust passage at a point above said exhaust valve means, said by-pass being oriented to direct a stream of air against said exhaust valve means traveling at a higher velocity than the air expelled there-through from said face piece, whereby said valve means is caused to open in excess of the normal amount for the volume of air being forced through said face piece with the result that the pressure is reduced within said face piece from the pressure normally associated with the particular volume of air.

2. A pressure regulator structure for pressure-type gas masks, comprising in combination a face piece connected to a downwardly extending

intake conduit, an outlet conduit disposed about said intake conduit to provide an annular exhaust passage between said exhaust conduit and said intake conduit, said exhaust conduit providing an annular valve seat at the lower end thereof, a diaphragm exhaust valve of flexible, resilient material carried by said intake conduit and extending thereabout adjacent said annular valve seat for cooperating therewith to close said exhaust passage, and a by-pass providing an annular passage communicating with the interior of said intake conduit and terminating in said exhaust passage immediately above said diaphragm valve, said by-pass being oriented to direct streams of air against said diaphragm valve, said intake conduit being of restricted cross-sectional area above the opening into said annular by-pass for maintaining a higher pressure in the region of said opening than within said face piece to cause said streams of air to travel at a higher velocity than the air expelled from said diaphragm valve to said face piece, whereby said valve means is caused to open in excess of the normal amount for the volume of air being forced through said face piece with the result that the pressure is reduced within said face piece from the pressure normally associated with the particular volume of air.

3. A pressure regulator structure for a pressure-type gas mask, comprising in combination concentrically arranged intake and exhaust conduits communicating with the interior of the face piece of said mask, the exhaust conduit being outermost to provide an annular exhaust passage between the outer exhaust conduit and the inner intake conduit, said exhaust passage being equipped with unidirectional valve means of variable volumetric capacity opening automatically in proportion of the volume of air forced through said face piece, inlet check valve means positioned at the inner end of said intake conduit, and a by-pass providing a passage extending from a lower point in said intake conduit into said annular exhaust passage at a point above said uni-directional valve means, said by-pass being oriented to direct a stream of air against said uni-directional valve means traveling at a higher velocity than the air expelled therethrough from said face piece.

4. A pressure regulator structure for pressure-type gas masks, comprising in combination a face piece connected to a downwardly-extending intake conduit, an outlet conduit disposed about said intake conduit to provide an annular exhaust passage between said exhaust conduit and said intake conduit, said exhaust conduit providing an annular valve seat at the lower end thereof, a diaphragm exhaust valve arranged to cooperate with said annular valve seat to close said exhaust passage, and a by-pass providing an annular passage communicating with the interior of said intake conduit and terminating in said exhaust passage above said diaphragm valve, said by-pass being adapted to direct streams of air against said diaphragm exhaust valve trav-

eling at a higher velocity than the air expelled from said face piece through said exhaust conduit.

5. A pressure regulator structure for a pressure-type gas mask, comprising in combination a face piece having an exhaust opening controlled by a valve member composed of flexible resilient material, said valve member being biased to its closed position by the resiliency of said valve member and opening automatically by the flexing of said valve member in proportion to the volume of air forced through said face piece, an air intake conduit communicating with the interior of the face piece adjacent said exhaust opening and a by-pass communicating with the interior of said intake conduit and terminating within said face piece near said exhaust opening valve member, said by-pass being arranged to direct a stream of air against said valve member traveling at a higher velocity than the air expelled therethrough from said face piece, thereby flexing said valve member away from its closed position and opening said valve member beyond its normal position for the volume of air being forced through said face piece, whereby the pressure is reduced within said face piece from the pressure normally associated with the particular volume of air.

6. A pressure regulator structure for a pressure-type gas mask, comprising in combination a face piece having an exhaust opening controlled by an outlet valve including a flexible resilient diaphragm and a valve seat arranged so that the diaphragm is normally in closed contact with the valve seat while flexing away from said valve seat in proportion to the volume of air forced through said face piece, an air intake conduit communicating with the interior of the face piece adjacent said outlet opening, a by-pass providing a passage extending from the interior of said intake conduit to a point near said outlet valve, said by-pass being adapted to direct a stream of air against said diaphragm, and pressure-reducing means inwardly of the opening into said by-pass for maintaining a higher pressure within said intake conduit in the region of the opening into said by-pass than within said face piece to cause the streams of air issuing from said by-pass to travel at a higher velocity than the air expelled through said exhaust opening from within said face piece, whereby said diaphragm is caused to open in excess of the normal amount for the volume of air being forced through said face piece with the result that the pressure is reduced within said face piece from the pressure normally associated with the particular volume of air.

#### References Cited in the file of this patent

#### UNITED STATES PATENTS

| Number    | Name    | Date          |
|-----------|---------|---------------|
| 2,007,440 | Brand   | July 9, 1935  |
| 2,051,023 | Bullard | Aug. 13, 1936 |